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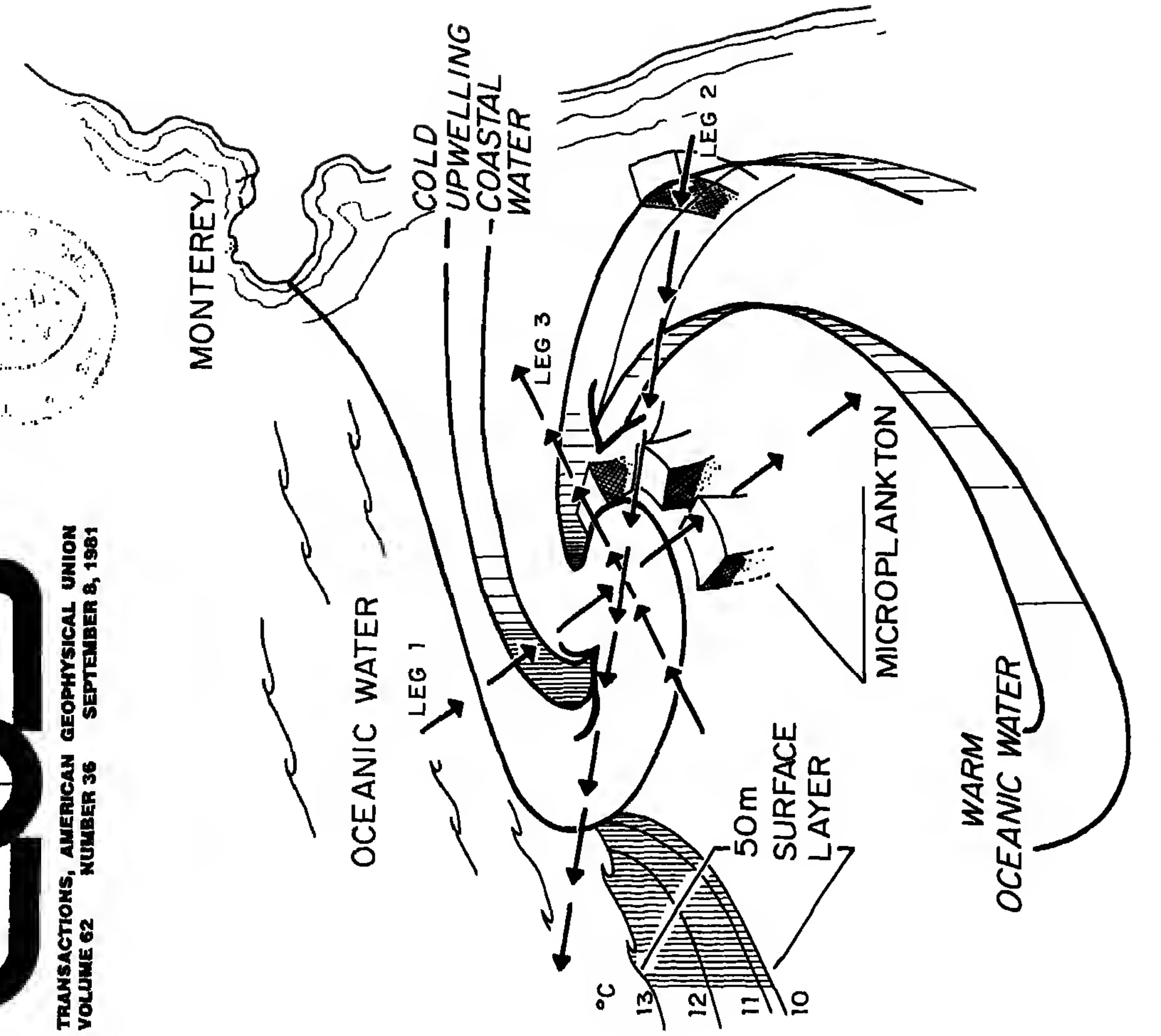

EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION VOL. 62, NO. 36, PAGES 657-664 SEPTEMBER 8, 1981

Tectonophysics

8130 Heat Flow
THERMAL REGIME OF THE ESCALANTE DESERT, UTAH, WITH AN ANALYSIS OF THE NEWCASTLE GEOTHERMAL SYSTEM
David S. Chapman (Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112) Monica D. Clement and Charles W. Mase

Twenty-five new heat flow measurements are presented for the Escalante Desert region within the Great Basin of the western U. S. Heat flow, excluding geothermal areas, ranges from 83 to 350 mW m^{-2} but much of the variability may be caused by deeply circulating groundwater re-distributing the regional flux. A subset of 10 sites drilled specifically to characterize the heat flow of the region yielded a mean of 100 mW m^{-2} with a standard deviation of 22 mW m^{-2}. A comparison of thermal conductivities of solid cylindrical discs and rock chips (rhyolite to andesite tuffs) confirmed the importance of porosity corrections to thermal conductivity measurements.

A "blind" geothermal system southwest of Newcastle, Utah, situated within the Escalante Desert has also been studied. Temperatures of 110°C are observed only 75 m below the ground surface. Heat flow results from 11 drillholes in this region yield values between 163 and 3065 mW m^{-2}. The 500 mW m^{-2} contour encloses an area of 9.4 km^2. By integrating the excess heat flux (above background) over the thermal anomaly we deduce a thermal power loss of 12.8 MW for this geothermal system, which corresponds to a subsurface water discharge of 32 kg s^{-1}.
J. Geophys. Res., Red, Paper 1B1316

8130 Heat Flow
ONE-DIMENSIONAL MODEL OF VAPOR-DOMINATED GEOTHERMAL SYSTEMS
[illegible] (The Aerospace Corporation, P.O. Box 92957, Los Angeles, CA 90009) and [illegible]

Vapor-dominated geothermal systems similar to the Geysers in northern California and Kamojang, West Java are modelled as one-dimensional structures in a porous medium saturated with water and steam. The model consists of a near surface condensate layer lying above a two-phase counterflow region with rising steam and descending water. Real systems have condensate layers several hundred meters thick and vapor-dominated reservoir temperatures near 511 K. [illegible] which reproduce these general characteristics have vol mass flow rate M to thermal conductivity [illegible] ratios smaller than about 2.5 x 10^{-7} [illegible] and permeability k to thermal conductivity ratios larger than 4.5 x 10^{-17} [illegible]. The mobile fluids in the main reservoirs of these models are essentially all steam. However, the reservoirs of real systems can contain substantial amounts of liquid water. Temperature T and pressure p data in the main reservoir of the Kamojang system are best fit by models with K/k between 10^{-15} and 10^{-14} [illegible]. Thus the permeability of the main reservoir is between 4 x 10^{-15} and 4 x 10^{-14} m^2 (4 and 40 millidarcies) for k = 4 J m^{-1} s^{-1} K^{-1}. These p and T data are not diagnostic of the overall flow rate through the Kamojang system. A relatively low permeability cap is required to stabilize the water layer above the steam region.
J. Geophys. Res., Red, Paper 1B1101

8150 Plate tectonics
THE PELUSIUM MEGASHEAR SYSTEM ACROSS AFRICA AND ASSOCIATED LINEAMENT SWARMS
D. Neev (Geological Survey of Israel, 30 Malkhe Yisrael St., 95 501 Jerusalem, Israel) J. K. Hall and J. M. Saul

The Pelusium Megashear System [Neev, 1977] extends from the "border zone" of Anatolia, along the eastern Mediterranean and across Africa from the Nile Delta to the delta of the Niger in the Gulf of Guinea. It appears to continue beyond Africa, via the Atlantic Equatorial Fracture Zone, into the Amazon Basin. It has functioned as a system of en echelon left-lateral megashears since Precambrian times. At least four other megasutures also cross Africa, paralleling the Pelusium System and similarly continuing into the Atlantic as fracture zones.

Swarms of lineaments observed in LANDSAT image mosaics of central and northeast Africa are associated with the Pelusium Megashear System. They are interpreted to be of tectonic origin. Linear dunes and yardangs oriented parallel to the lineaments appear to have been formed by winds deviated and channeled by the tectonic lineaments. These eolian features should not be considered therefore as reliable indicators for higher altitude atmospheric circulation. Whereas the patterns of the former are affiliated to that of the Pelusium Megashear System, they are not related to most of the other nearby geologic features.

Both the Pelusium Megashear System and its associated lineament swarms exhibit northeastward convergence patterns which suggest counterclockwise rotation of the crust. These probably result from left-lateral movements within the asthenosphere which have continued since the Precambrian. (LANDSAT, geosuture, lineament, eolian landform).
J. Geophys. Res., Red, Paper 1B1192

8170 Structure of the lithosphere
THE MARQUESAS-LINE SWELL
S.T. Crough (Department of Geosciences, Purdue University, West Lafayette, Indiana 47907) and R.D. Jarrard

Mapping of depth anomalies in the central Pacific reveals a broad, shallow region herein termed the Marquesas-Line Swell. It has the morphology and geoid signature typical of a mid-plate hotspot swell, and probably marks the Tertiary trace of the Marquesas hotspot. The swell is elongate in the NW-SE direction, about 800 m high, and about 1500 km wide. It appears to extend continuously between the Marquesas Islands and the Line Cross Trend. A positive geoid height anomaly over the swell can be separated from the large regional trend. The transfer function between depth anomaly and geoid height is not well-defined, but is consistent with local isostatic compensation with an average root depth of about 30 km (1 to km, 95% confidence interval) below the swell's surface. Direct spatial comparisons between geoid height and depth anomaly suggest that this root depth is constant along the length of the swell and has a value of about 40 km (± 10 km, 95% confidence interval). The crest of the swell appears to subside as normal seafloor which is only 21 my old, the prediction of the lithospheric thinning hypothesis. A permanent density decrease within the lithosphere can also explain the subsidence and geoid height anomaly; roll-cell dynamic uplift can explain the subsidence but is difficult to reconcile with the geoid data. (Epeirogeny, hotspots, geoid).
J. Geophys. Res., Red, Paper 1B1172

8170 Structure of the lithosphere
ON INCLINED FEATURES IN THE ICELAND RESEARCH PROJECT DRILLCORE
J.M. Hall, C. Wells and E.L. Hall (Dept. of Geology, Dalhousie University, Halifax, Nova Scotia B3H 3J5, Canada)

Precise dip and direction of dip measurements are reported for 140 dike contacts, 128 bedding features in volcaniclastics and for 30 planar upper surfaces of secondary mineral infillings in vesicles in flows from a 1920 m drillcore from Reydarfjördur, eastern Iceland. The drillcore extends from about 1.6 km to 3.6 km beneath the original surface of the crustal section. Lava flow dips and directions of dips are reported for a 750 m exposed section situated directly above and in continuity with the drillcore section. While dips and within-unit differences in dip direction appear to be accurately represented by the measurements, absolute directions are only known inaccurately. This is a consequence of the use of the paleomagnetic method of obtaining dip direction for which both high site latitude and tectonic rotation contribute to poorly constrained results.

The main results of the study are the commonplace irregular form of dike contacts, such that the drillhole often entered and exited from the same side of a dike, evidence for the presence of only one population of minor intrusions and the ability to recognise where several sections of intrusives in the drillcore belong to the same dike. The irregular form of the dikes prevents a reliable estimate of change of dilation with depth from being obtained. It is clear, however, that a sheeted dike complex does not occur in the upper 8 km of the crust in the area.

Measurement of bedding features in the volcaniclastics shows them to be considerably dispersed, particularly in dip direction. Tectonic tilt in the crustal section increases from 11° at sea level to an extrapolated value of close to 17° at 4 km crustal depth. Corresponding lava deposition rates increase from 1620 m/my to 2580 m/my respectively. Tectonic tilting was probably complete by the time of deposition of the last components of the secondary mineralization event in the vesicles of lava flows.

The optimum conditions for this type of tectonic investigation where measurements made on vertical drillcore are used, are high speed diamond drilling and original magnetization at middle to low, but not equatorial latitudes.
J. Geophys. Res., Red, Paper 1B1391

8199 General or miscellaneous
CONSTRAINTS ON GEOLOGICAL STRAIN RATES: ARGUMENTS FROM FINITE STRAIN STATES OF NATURALLY DEFORMED ROCKS
O.A. Pfiffner (Geologisches Institut, ETH-Zentrum, CH-8092 Zürich, Switzerland) J.G. Ramsay

The values of the finite strains in rocks deformed during natural geological deformation processes are summarized. These data are compared with models of strain accumulation by processes of progressive pure shear (the most efficient way of building finite strain from a specific strain rate) and progressive simple shear (a geologically common process, but a less efficient way of building a finite strain from a specific strain rate). The geological data are best interpreted by dictortional strain rates between 10^{-13} sec^{-1} and 10^{-15} sec^{-1}.
J. Geophys. Res., Red, Paper 1B1245

Editorial

Is Deferred Giving for You?

AGU GIFT 1980 1985

You have been reminded frequently of the opportunities for direct gifts to AGU; another way of supporting an organization like the AGU is through 'deferred giving.' The AGU-GIFT Steering Committee believes that deferred giving can be a most important element in its 5-year drive to raise $1,000,000 through the membership. Your committee expects that deferred giving is likely to have special appeal to the longtime members of the Union and to those who are retired; however, others should also consider deferred giving. One younger member has already indicated to the committee that he is providing for a small percentage of his estate to go to the Union. At the same time he said that he expects the Union will have to wait 50 years for this portion of his gift.

Deferred giving is the pledging of money or other assets to be paid later according to a prearranged plan. Most of us have become familiar with the term, or at least the practice, in the past few years. If you are a member of a club or a church, are an alumnus of an institution of higher learning or are the parent of a student or alumnus of such an institution, or are affiliated with a particular party, I am sure the opportunity for deferred giving has been presented to you.

The options for deferred giving are many and varied. They range from very simple gifts or bequests to intricate arrangements that provide for the complex situations in which some donors are involved. These complexities have to do with the size of a donor's estate, inheritance and income tax situations, numbers of heirs, and a variety of other factors. This is why potential donors should assure themselves, through whatever professional advice they may think desirable, that they are making the best moves for their unique situation. The AGU can offer some general guidance upon request. Some of the more common types of deferred giving are mentioned below.

Wills. Donors who wish to make a contribution at their death may find it convenient to do so by providing for it in a will. The AGU may be the primary beneficiary, secondary beneficiary, or a contingent beneficiary.

Life Insurance. It may be convenient for one who wishes to make a gift to the AGU to do so through a life insurance policy—either by changing the beneficiary to the AGU on an existing policy or by purchasing a new policy.

Trusts. An increasingly popular method of giving is through a trust. Trusts are more commonly used when the gift is substantial, but some trust arrangements are amenable to smaller amounts. For example, *pooled income trust* is one in which the gifts from many donors are commingled and invested in a trust set up by the donee organization. Each donor retains for life a right to a share of the income. Upon the death of a donor the organization is entitled to remove the gift from the trust.

The *charitable remainder trust* is similar, but in this case each donor normally establishes his or her individual trust. The trust's assets would revert to the AGU upon the death of the beneficiary or at some other specified time. On the other hand, in a *charitable lead trust* the AGU would receive income from the trust up to a specified event or date and then the trust is distributed to other beneficiaries in accordance with its terms.

Each of these trust vehicles has its own special tax and personal advantages, which you may want to consider.

Simple deferred gift. Donors can simply pledge that at some future date they will give the AGU a certain amount in cash, securities, or other property of value. This can be a once only arrangement or by installment, such as a certain amount per year over a specified number of years. For example, a member might pledge $500 a year, starting in 1981, for 5 years over the interval of the Union's 5-year drive just starting. This is the approach proposed in the AGU-GIFT brochure that was sent to all U.S. members at the end of 1980.

All gifts are, of course, deductible for U.S. income tax purposes. There may be substantial tax advantages if appreciated securities are donated. If you are in the middle or upper tax brackets, it is possible to plan your gift such that the government is, in effect, making the lion's share of your contribution.

Many of us in the AGU who are senior citizens are perhaps having an easier time in the midst of inflation than the average citizen. First, there are the usual reasons: our security has already been established; our children, for the most part, are grown, gone, and on their own; our needs are less than earlier in life; our houses are often paid for; many of our insurance policies have matured; and on and on.

Second, many of us are on federal retirement, Social Security, or both, and these systems have provisions for inflation.

The fact is that many of us who are senior citizens are in a good position to make a contribution to the Union GIFT Fund. Some can and, we hope, will make substantial contributions. But each individual is the best arbiter of his or her own situation. Only you can make the decision.

Whether your gift is to be immediate, deferred, or a combination, in the words of our Union President, Tuzo Wilson: 'Consider what AGU has done and is doing for you and what you can now do.'

John Reed
Steering Committee
AGU-GIFT

EOS
TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

The Weekly Newspaper of Geophysics

Send double-spaced manuscripts (four copies) to *Eos*, AGU, 2000 Florida Avenue, N.W., Washington, D.C. 20009, or send them directly to one of the associate editors with a copy to the above address.

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Cover. The aurora seen from Bossekop, Norway, on January 21, 1839, at 8 P.M. from *Majestic Lights: The Aurora in Science, History, and the Arts* by Robert H. Eather, published by the American Geophysical Union. Courtesy of Widener Library, Harvard University. (See news item p. 665.)

News

Hottest U.S. Geothermal Find

A geothermal test hole drilled 810 m into the summit crater of Newberry Volcano in Oregon measured 190°C, the hottest temperature measured so far in a United States geothermal energy prospect. What's more, a high temperature gradient discovered in the lower sixth of the test hole may point to greater potential than was previously thought for geothermal energy in the Cascade Range.

Scientists from the U.S. Geological Survey, lead by David Blackwell of Southern Methodist University, found that in the hole's lower 140 m the temperature rose at a rate equivalent to about 600°C per kilometer. The worldwide continental average is about 30°C per kilometer.

Additional tests are needed to determine if there would be enough flow to allow a power generation plant to convert geothermal energy to electricity. There is little or no flow now.

'The high gradient tends to confirm a theory that the low temperature at shallow depths . . . may reflect more the effects of shallow lateral flow of cool groundwater rather than the real geothermal energy potential,' according to Robert Tilling, chief of the USGS Office of Geophysics and Geochemistry. These low temperatures in shallow depths have discouraged previous geothermal exploration in the nearby Cascade Range, he explained. 'We think the high precipitation and generally high rate of groundwater recharge in the Pacific Northwest have combined to dilute and cool its geothermally heated water and to lower its rock temperatures at shallow depths during the past thousand years or so.'

Similar encouraging results were reported at a Mount Hood test well and in the Canadian Cascades. Tests completed at Mount Hood at the end of July showed that the water temperature at a depth of 1219.2 m was about 80°C; flow rate was about 7 l/s. While not unusual on its own, the well's yield, combined with that of Newberry Volcano, could encourage increased geothermal exploration. And the heat's on in the Canadian Cascades as well. Geothermal exploration project scientists measured temperatures higher than 200°C in the Meager Creek area of British Columbia. In addition, eruptions during the last year and a half from Mount St. Helens manifest the internal heat and geothermal activity in the Cascade Range.

Arctic Ice Core: Clue to Ancient Climates

An international team of researchers recently drilled 2,037 m to bedrock in the Greenland Ice Sheet and extracted the longest ice core ever retrieved in the arctic region, according to information from the National Science Foundation. The core, from a site called Dye 3 in southeastern Greenland, will enable scientists to learn more about the climates and environments that existed during the past 100,000 years. The cores will be examined for traces of repetitive climate cycles; from these studies, projections may be made on future climate.

The Dye 3 drilling project is the second one in which bedrock was reached in Greenland. In 1966, a 1,387 m core was extracted at the Camp Century site in northwestern Greenland. A longer core (2,164 m) was obtained in Antarctica at Byrd Station.

Tiny bubbles of air trapped in the 10-cm-diameter, 2-m-long core sections are clues to the prehistoric earth's atmosphere; dust in the ice reveals volcanic activity. Ancient temperatures can be determined by the ratio of two forms of oxygen.

Researchers from Denmark (led by Willi Dansgaard) and from Switzerland (headed by Hans Oeschger) joined with U.S. scientists (led by Chester C. Langway, Jr., of the State University of New York at Buffalo) in the Greenland Ice Sheet Program (GISP). GISP's two main goals are to learn more about how ice sheets flow and to study chemicals and particles in the ice to improve knowledge of global climate.

Shedding Light on the Aurora

For want of cameras, electronic monitoring, and computer analysis, scientists turn to literature for descriptions of the aurora borealis of the Viking era. Some of those who turned to Norse literature say that the writings between 700 and 1200 A.D. refer directly to the aurora, but two geophysicists from Norway disagree. A. Brekke at the University of Tromso and A. Egeland at the University of Oslo say that surprisingly little direct evidence of the aurora is woven into the literature. Some of what has been interpreted as reference to the aurora is a misinterpretation. A correct interpretation, they say, 'can shed new light on our knowledge about solar activity, the geomagnetic field, and the auroral oval.'

Low solar activity coupled with a strong geomagnetic field can explain the lack of direct reference to the aurora, Brekke and Egeland say. References aren't included in the writings because the auroras probably were more to the north in Scandinavia than they are today; most authors of Norse epics didn't witness the auroras but, instead, heard stories of them.

Two pieces of Norse literature examined by Brekke and Egeland, in their paper 'Reference to the Aurora in Norse

Literature,' are *The King's Mirror* and *The Poetic Edda*.

Written as a conversation between a father and his son, *The King's Mirror* was most likely written around 1230 A.D., and certainly before 1263 A.D. The long-forgotten author is believed to have lived in the middle of Norway, south of the Arctic Circle. One conversation clearly centers on the aurora: 'That matter you have often inquired about what can be (sic) and which the Greenlanders call the northern lights (norduriose),' the father told his son, 'I have no clear knowledge about. I have often met people who have spent a long time in Greenland, and they do not seem to know definitely what it is either.'

Nevertheless, in a later conversation, the father offers explanations of the aurora: 'Because some believe that fire circles about the ocean and all the bodies of water that stream about on the outer sides of the globe; and since Greenland lies on the outermost edge of the earth to the north, they think it is possible that these lights shine forth from the fires that encircle the outer ocean. Others have suggested that during the hours of the night, when the sun's course is beneath the earth, an occasional gleam of its light may shoot up into the sky; for they insist that Greenland lies so far out on the earth's edge that the curved surface which shuts out the sunlight must be less prominent there. But there are still others who believe (and it seems to me likely) that the frost and the glaciers have become so powerful there that they are able to radiate forth these flames.'

The father probably never saw the aurore, but heard about it from people visiting Greenland, Brekke and Egeland say. If this is true, than 'there are good reasons to believe that the aurora was an uncommon phenomenon in Norway in the middle of the 13th century.' They continue, 'Since the aurora was known in Greenland, however, it must be concluded that the oval either was very much shrinked (sic) with respect to the present oval or that the oval was situated differently with respect to present position.'

Statements relating the aurora to poems in the epic *The Poetic Edda* often are based on misconceptions, Brekke and Egeland maintain. The Edda is a collection of poems that may date back to 700 A.D. but were written mostly between 1000 and 1100 A.D. When Icelander Finnur Magnusson translated the hero-idolizing poems in 1821 (the first time the *Edda* was completely translated), he was strongly influenced by mythology and national romanticism, the authors say. Magnusson's translation of the poems embodies a large gallery of gods, heros, and giants who personified certain forces and phenomena in nature. For example, he attributed the northern lights to the reflections of the Valkyries' shields. Such indirect reference is odd, Brekke and Egeland say, because other natural phenomena like rainbows, airglow, and lightning are plainly referred to in the *Edda*. It is clear, they say, that the authors of the poems in the *Edda* were aware of optical visions in the air, and it is puzzling that the aurora do not receive similar treatment.

So, Brekke and Egeland searched for an explanation. They believe, from their review of geomagnetic, palaeomagnetic, and solar studies, that low solar activity accompanied by a strong magnetic field caused the auroral oval to move toward the pole, thereby making the aurora an uncommon site in parts of Scandinavia and Greenland. Variation in the strength of the geomagnetic dipole field, they explain, will move the auroral oval poleward if solar activity is constant.—*BTR.* ⊠

New Geophysics Institute at U Texas

A new institute for Geophysics has been established at the University of Texas at Austin. It will administer ongoing research programs in the university's geophysics laboratory in Galveston, Texas. Home base for UT's two research ships, the Galveston lab had been a unit of the university's Marine Science Institute and some related research programs in the geological sciences department.

Paul Donoho, a research scientist at the Galveston lab, has been appointed acting director of the institute. ⊠

Geophysicists

Three of the eight scientists appointed to the Atlantic Richfield Company's new Science Advisory Council are AGU members. *Leon T. Silver* (Division of Geological and Planetary Sciences at Caltech), *Laurence Louis Sloss* (Department of Geological Sciences, Northwestern University), and *Robert White* (University Corporation for Atmospheric Research) will join council chairmen Philip Handler, former president of the National Academy of Sciences, in advising the company on emerging and future technologies.

Drew

Priscilla C. Grew has been appointed by California Governor Edmund G. Brown, Jr., as a Commissioner of the California Public Utilities Commission in San Francisco. She was formerly the director of the California Department of Conservation, which includes the California Division of Mines and Geology.

Peter W. Hacker recently began a 2-year term as program director of the Physical Oceanography Program at the National Science Foundation. He succeeds *Ya Hsuan*, who has returned to Florida State University following a 1-year stint at NSF. Hacker was program director of the Physical Oceanography Program for 3 years prior to Hsueh's term. Previously, Hacker was at the Johns Hopkins University and the Chesapeake Bay Institute.

Peter Niiler has been appointed a Distinguished Visiting Scientist at the Jet Propulsion Laboratory. A leading authority on the physics of large-scale, long-term circulation of the oceans and the interaction between the upper layers of the ocean and the lower layers of the atmosphere, Niiler has been a professor of oceanography since 1974 at Oregon State University. He was previously a professor of oceanography at Nova University in Ft. Lauderdale, Fla., and has held research appointments at Harvard University and the Woods Hole Oceanographic Institution.

Forum

Methane

I was surprised to read (*Eos, 62*(32), 618, 1981) that a Caltech-Gulf Research and Development Company gas emission monitoring study along the San Andreas rift zone has so far recorded no methane. The same story credits me with finding methane along the East Pacific Rise, in Tibet, and in other exotic locations. However, right here in our own backyard my laboratory has been monitoring methane emissions at more than a dozen sites for more than 5 years, on the San Andreas, San Jacinto, and Elsinore faults [*Craig et al.*, 1980a]. These data have been reported to USGS at 6-month intervals, to Cal Tech on a number of occasions, and presented at AGU meetings [*Craig et al.*, 1980a]. Your story clearly does not inspire great confidence in industry's exploration for new natural gas deposits.

For the record, methane may be found [*Craig et al.*, 1980*b*] at sites along the San Andreas in Southern California in the following concentrations (cc (STP)/kg of water): Arrowhead Hot Springs (0.04), Desert Hot Springs (0.004), Palm Springs (0.03), and in the Salton Sea area at Hot Mineral Well (0.20), Bashford's Baths (0.60), Pillsinger Well (0.40), and at Niland Slab Well (0.5 to 0.05, decreasing with time). Methane is also found at four sites on the Elsinore fault and two sites on the San Jacinto. Concentrations up to 1.5 cc/kg are found at Murrieta Hot Springs and Eden Hot Springs. Admittedly, these are not Lake Kivu concentrations, but our data do indicate that methane occurs in easily measurable concentrations almost everywhere along these major fault systems where hot springs and thermal wells are found. We monitor our sites at monthly intervals and will be happy to provide guides and porters to Gulf's methane sniffers.

H. Craig
Scripps Institution of Oceanography
University of California at San Diego

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Craig, H., Y. Chung, R. Poreda, J. Lupton, and S. Damasceno, Fluid-phase earthquake precursor studies in Southern California, *Eos, 61*, 1035, 1980a.

Craig, H., Y. Chung, R. Poreda, J. Lupton, and S. Damasceno, Investigation of radon and helium as possible fluid-phase precursors to earthquakes, *Tech. Rep. 13, SIO Ref. 80–40*, Scripps Inst. of Oceanogr., Univ. of Calif., San Diego, 1980b.

New Publications

Deconvolution of Geophysical Time Series in the Exploration for Oil and Natural Gas

Manuel T. Silvia and Enders A. Robinson, *Dev. in Petroleum Sci.*, vol. 10, Elsevier, New York, xii + 251 pp., 1979, $49.75.

Reviewed by Ralphe Wiggins

This book fills a long-standing gap in the geophysical literature. It is a nearly complete discussion of the theory of predictive deconvolution. The presentation is well organized, consistent, and generally easy to read. Before this book appeared, most of the relevant theory had been published in papers, many of which were authored or coauthored by Robinson. These papers were written at different levels, were often repetitive from one to another, and did not always have consistent use of symbols. Nevertheless, a collection of these papers was the best available source for learning about the theoretical intricacies of deconvolution.

The major thrust of the book is divided into three parts: (1) a discussion of the geologic and statistical models that are the basis of predictive deconvolution, (2) a discussion of homomorphic analysis and spectral factorization, and (3) a discussion of predictive deconvolution. The modeling section gives a clear statement of the assumptions necessary for the derivation and justification of predictive deconvolution. It also shows why predictive deconvolution is a reasonable approach, at least for decoding the signals from plane waves traveling in a plane-layered earth. The section on homomorphic analysis is perhaps the best description of this subject that I have seen. The authors give an admirable presentation of how homomorphic analysis ties together many of the apparently unrelated aspects of the algebra of deconvolution. The third section on deconvolution is also excellent. The authors discuss the theory of least square filter design for predictive and gapped deconvolution, various methods for estimating autocorrelations, Burg's algorithm, homomorphic deconvolution, and state-space filtering. All of these discussions are lucid and balanced without 'evidence of 'beating a drum' for any particular method. Historical precedents are given for many of the developments.

Attached to the beginning of the book is a chapter describing seismic field techniques. At the end of the book is a chapter illustrating and listing a set of subroutines that perform most of the operations discussed in the more theoretical sections. Even though I know that many readers will find the subroutines useful, these terminal chapters seem somewhat out of place with respect to the style of the rest of the book.

In fact, the style of this book is the most curious feature. It seems to be a mathematics book written in English. Any theorems or proofs present are thinly disguised as discussion. Frequently, abstract symbols are replaced by words. The book contains a lot of physical motivation and yet there are no practical examples, neither seismograms nor exercises. For example, we are left to accept the authors' assurance that the reflection seismic method was 'greatly enhanced by the introduction of digital deconvolution.' Similarly, the authors have presented computer routines with no mention of any associated numerical problems. Neither the need for adding a small constant to the center term of the autocorrelation in order to stabilize the inversion of the normal equations, the practical effects of short gap intervals or filter length on deconvolution outputs, nor the serious consequences for homomorphic deconvolution caused by the nonrobustness of phase unwrapping algorithms are ever mentioned. Anyone who applies the subroutines as presented may encounter a few surprises.

My conclusion is that this is a very informative book that is neither theoretical nor practical. It would be of interest to students and research-oriented professionals. It is generally easy to read even when there seems to be an excess of words in some parts, and it covers most of the theoretical properties of predictive deconvolution. There is no hint elsewhere of recent trends in the seismic exploration industry to exploit the non-Gaussian statistics of reflection seismograms.

Ralphe Wiggins is with the Mobil Field Research Laboratory, Dallas, Texas.

New Listings

Items listed in New Publications can be ordered directly from the publisher; they are not available through AGU.

Aquaculture Economics: Basic Concepts and Methods of Analysis, Y. C. Shang, Westview Press, Boulder, Colorado, xvi + 153 pp., 1981, $20.00.

Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibria in Natural Waters, 2nd ed., W. Stumm and J. J. Morgen, John Wiley, New York, xiv + 780 pp., 1981, $45.00.

Bottom-Interacting Ocean Acoustics, W. A. Kuperman and F. B. Jensen (Eds.), Planum, New York, xi + 717 pp., 1980, $75.00.

Climate's Impact on Food Supplies: Strategies and Technologies for Climate-Defensive Food Production, L. E. Slater and S. K. Levin (Eds.), Westview Press, Boulder, Colorado, xvii + 243 pp., 1981, $22.00.

Earthquake Risk and Damage Functions: Application to New Madrid, B. Liu, C. Hsieh, R. Gustafson, O. Nuttli, and R. Gentile, Westview Press, Boulder, Colorado, xvii + 297 pp., 1981, $32.00.

The Estuarine Ecosystem, D. S. McLusky, John Wiley, New York, viii + 150 pp., 1981.

Facies Interpretation and the Stratigraphic Record, A. Hallam, W. H. Freeman, San Francisco, California, xii + 291 pp., 1981, $27.95. (herdbound).

Free Oscillations of the Earth, E. R. Lapwood and T. Usami, Cambridge University Press, New York, xii + 243 pp., 1981, $49.95.

A Guide to Obtaining Information From the USGS, 1981, USGS, 42 pp., 1981, (Available free of charge from the U.S. Geological Survey, Text Products Section, Eastern Distribution Branch, 604 South Pickett St., Alexandria, VA 22304.)

Sedimentary Petrology: An Introduction, M. E. Tucker, John Wiley, New York, viii + 252 pp., 1981, $29.95.

Spaceborne Synthetic Aperture Radar for Oceanography, R. C. Beal, P. S. DeLeonibus, and I. Katz (Eds), Johns Hopkins Press, Baltimore, Maryland, 215 pp., 1981, $19.50 (hardcover).

Classified

EOS offers classified space for Positions Available, Positions Wanted, and Services, Supplies, Courses, and Announcements. There are no discounts or commissions on classified ads. Any type that is not publisher's choice is charged for at display rates. EOS is published weekly on Tuesday. Ads must be received in writing on Monday 1 week prior to the date of the issue required.

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For special rates, query Robin Little, 800-424-2488.

POSITIONS AVAILABLE

Petrologist: Northern Illinois University. Applications are invited for a tenure track position in igneous or metamorphic petrology at the assistant or associate professor level beginning either January, 1982 or August, 1982. A Ph.D. degree is required and post-doctoral research experience is preferred. The successful candidate will be expected to pursue an active research program, teach at the undergraduate and graduate level, and direct Masters and Ph.D. graduate research work. Facilities housed within the Department of Geology include a fully automated electron microprobe, SEM, solid-source and gas-source mass spectrometers, AA, XRD, and XRF. To receive full consideration, please send resume, statement of research interests, and the names of three references, by November 1, 1981, to Jonathan H. Berg, Search Committee Chairman, Department of Geology, Northern Illinois University, DeKalb, Illinois, 60115.

An equal opportunity/affirmative action employer.

Engineering Geologist/Geophysicist. The Department of Geological Sciences, University of Saskatchewan, has a vacant tenurable position in engineering geology/geophysics. Applicants should be qualified to teach undergraduate and graduate courses and to conduct research in engineering geology. A background in structural geology may be appropriate. Well-equipped facilities are available for research in rock mechanics, fluid flow through porous media, acoustic, and electrical properties of rocks, and permafrost. Good opportunities exist for joint research with qualifications and experience. Send applications, detailed personal resume including the names of at least three referees, and other supporting data to Dr. W.O.E. Caldwell, Head, Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan, S7N 0W0.

Please note: until November 15, 1981 consideration will be given only to applicants who are Canadians or landed immigrants, after that date all applications will be considered.

Director: Geodetic Survey, NOAA. The National Oceanic and Atmospheric Administration (NOAA) announces a Senior Executive Service Vacancy for the position of Director, Geodetic Research and Development Laboratory (OROL) in the National Geodetic Survey, a component of the National Ocean Survey. The duty location is Rockville, Maryland. The salary range is $47,660–$59,112.50 per annum. Duties include providing technical and administrative supervision over employees and activities of GROL; advising officials on the state of scientific knowledge in geodesy and making recommendations for research and development; exercising scientific and technical knowledge of contributing publications to professional journals and making presentations at national and international meetings; and advising and consulting scientists and executives in improvement of geodesy and related fields. Experience in management of scientific programs, geodesy, and solid earth sciences is required. Apply to: NOAA/NOS-6001 Executive Boulevard, Rockville, Maryland 20852. Attn: MB/PER15:TR

NOAA is an equal opportunity employer.

Geophysicist/Geologist: The University of Texas at Austin, Institute for Geophysics. Four research scientist positions are now available at the University of Texas Institute for Geophysics in the fields of marine geophysics, tectonics, seismic stratigraphy, seismic reflection techniques and data processing, ocean bottom seismometer (OBS) and other seismographic instrument design and development, earthquake seismology, and lunar and planetary seismology.

The Institute maintains a modern dockside facility at Galveston, Texas (Galveston Marine Geophysics Laboratory), where a new marine building will be built next year. There is also a component of the Institute based in Austin. The Institute has a modern computer facility for processing and analyzing geophysical data and will be obtaining a new VAX interactive computer system early next year. The Institute maintains two research vessels, the R/V IDA OREEN and the R/V FREQ H. MOORE, which have capabilities for conducting marine geophysical surveys including the collection of magnetics, multifold seismic reflection data (48-channel), sonobuoy data, and OBS refraction and earthquake data. This two-ship capability offers the exciting opportunity to conduct two-ship seismic experiments. In addition, the Institute operates extensive seismographic networks in several Central American and Caribbean countries. The Institute maintains close ties with the staff and facilities of the Department of Geological Sciences, which include modern radiometric, isotope, and paleomagnetic laboratories.

A Ph.D. degree is required, preferable in Geology or Geophysics. Salaries are negotiable depending upon experience and qualifications. The person must have the ability and desire to work on group projects, conceive and initiate new projects, collect and reduce data, and publish the results. If you are interested in this excellent opportunity to pursue a challenging career in the forefront of geophysical research in an academic setting, please send your qualifications and references to:

Director
The University of Texas
Institute for Geophysics
Galveston Marine Geophysics Laboratory
700 The Strand
Galveston, Texas 77550.

The University of Texas is an equal opportunity/affirmative action employer.

Space Physics Research Position. Applicants with background in interplanetary space, auroral and magnetospheric research, and/or space instrumentation are sought. Successful candidates will work with ISEE particle data and/or with auroral X-ray imaging research that uses the newly developed X-ray cameras. These positions have not been filled and are available now. Send your resumé to Professor George K. Parks, Space Sciences, Geophysics Program, University of Washington, Seattle, WA 98195.

The University is an equal opportunity employer

Research Associate/Electron Microprobe. The Electron Microscopy Center at Texas A&M University invites application for the position of electron microprobe specialist. Applicants should possess a working knowledge of WDS and EDS spectrometers and accompanying computer and software programs and preferably have had experience in the geological sciences.

The primary duties of the position are to oversee and maintain (with the aid of service contracts) the electron microprobe and ancillary equipment and to assist in teaching graduate course laboratories dealing specifically with electron microprobe analysis.

Salary will be a maximum of $20,000-12 months.

Applicant should send supporting data and letter of recommendation to:

Dr. E. L. Thurston
Texas A&M University
Geological Sciences Building
College Station, Texas 77843

Texas A&M is an equal opportunity/affirmative action employer.

California Space Institute, University of California, Santa Barbara: Research position in Remote Sensing. Basic and applied research in some combination of remote sensing of coastal zones, land use/land cover, natural and agricultural vegetation, and soil moisture with skills in information systems, automated image analysis, and quantitative modelling. We seek an independent worker with the goal of deepening and widening existing work in these areas on this campus. Ph.D. preferred. Rank and salary commensurate with experience. Closing date: November 30, 1981. Submit: resume; a brief account of research interests; and names of three professional referees to Dr. David S. Simonett, Department of Geography, University of California, Santa Barbara, California, 93106.

The University of California, Santa Barbara, is an equal opportunity/Affirmative Action employer.

University of Maryland/Faculty Position. The University of Maryland invites applications from highly qualified scientists for a tenure track faculty position at the assistant or associate professor level in the Department of Meteorology. Candidates must have a Ph.D. in meteorology, physics, engineering or chemistry and have an area of specialization that will enable them to lead a research program in environmental physics and air pollution. The research activity of the candidate should complement the meteorological research of the Department and continue the strong interaction in the physical sciences across departmental lines. Duties will include teaching undergraduate courses related to environmental physics and air pollution and developing an active research program. Salary will be commensurate with qualifications and experience. All applicants should send curriculum vitae, a brief statement of research interests and names, addresses and telephone numbers of three professional references to: Professor Ferdinand Baer, Chairman, Department of Meteorology, University of Maryland, College Park, MD 20742. Closing date for applications is 1 December 1981.

The University of Maryland is an equal opportunity/affirmative action employer.

Faculty Positions: The University of Iowa. The Department of Physics and Astronomy anticipates one or two openings for tenure-track faculty in August 1982. One or more visiting professorships, at any rank, are also expected to be available. Preference will be given to candidates with research activity in the following experimental and theoretical areas: astronomy, astrophysics, atomic physics, condensed matter physics, elementary particle physics, nuclear physics, plasma physics, and space physics. The positions involve undergraduate and graduate teaching, guidance of research students, and personal research. Interested persons should send a résumé, a statement of research interests, and the names of three professional references to Search Committee, Department of Physics and Astronomy, The University of Iowa, Iowa City, IA 52242.

The University of Iowa is an equal opportunity/affirmative action employer

University of California, Santa Barbara/Assistant Professor of Geography. Tenure track position available July 1, 1982. Ph.D required prior to appointment. Strong commitment to research and teaching and good background in computer and mathematical quantitative skills required. Major area of specialization should be cartography with other research and teaching interests in human geography. Submit resume, bibliography, and names of three referees to: Dr. Reginald G. Golledge, Chairman, Department of Geography, University of California, Santa Barbara, CA 93106. Closing date: December 31, 1981

Equal opportunity-affirmative action employer.

University of New Orleans/Geophysicist. Applications are invited for a permanent faculty position commencing August 1982, in exploration geophysics. The Ph.D. or equivalent experience required.

Appointee will be expected to teach graduate and undergraduate courses in geophysics and general geology, conduct a program of research, supervise theses and oversee a program in geophysics. The position will be at the assistant professor level or higher depending on background. Applications are encouraged from individuals with industrial experience, including recent retirees.

Applicants should send a letter outlining interest in position, complete résumé, and three letters of recommendation to Dr. Gordon Frey, Department of Earth Sciences, Lake Front, University of New Orleans, New Orleans, LA 70122.

UNO is an equal opportunity/affirmative-action employer. Applications from minority groups are specifically invited.

City University of New York, Brooklyn College: Faculty Positions. The Department of Geology anticipates filling several tenure track positions at Full Professor level. (Salary range up to $43,400). Highly qualified individuals will be considered for distinguished appointments at an additional $5,000.

While candidates who have distinguished themselves in any field are welcome to contact us, we are particularly interested in openings in energy resources (coal petroleum), exploration geophysics, environmental geology or hydrogeology, coastal sedimentology, economic geology.

Successful applicants will be required to institute an active research program, supervise Master's and Ph.D. theses. Nominations and applications with current vitae should be sent to: Dr. S. Bhattacharji, Chairman, Dept. of Geology, Brooklyn College of City University of New York, Brooklyn, New York, 11210. Positions open until filled.

Brooklyn College, CUNY, is an affirmative action/equal opportunity employer.

University of Hawai'i/Faculty Positions. The Department of Geology and Geophysics and the Hawaii Institute of Geophysics have openings for the 1981–1982 academic year. Rank is open dependent on qualifications. We are seeking persons who will participate in our teaching and research program in any of the following areas: (1) structural geology and marine tectonics; (2) hydrology and engineering geology, (3) marine seismology, magnetics, and gravity. To apply send a letter of interest, a current vita and 3 letters of reference to Dr. S. O. Schlanger, Chairman, Department of Geology and Geophysics, University of Hawaii, 2525 Correa Road, Honolulu, Hawaii 96822 (808-948-7826), or Dr. C. E. Helsley, Director, Hawaii Institute of Geophysics, same address (808-948-8760). Open until filled.

The University of Hawaii is an affirmative action and equal opportunity employer

Computer Programmers. Looking for computer programming talent, all experience levels, for selected locations around the country. Call Dr. Wayne Mount at (617) 259-9685 to obtain details, and/or send resume to GAC, Box 177, Lincoln, MA 01773

Research Position in Chemical Oceanography. California Institute of Technology, Division of Geological and Planetary Sciences. The position of research fellow is being offered at Caltech for research in oceanography. Investigation of the isotopic composition of neodymium and rare earth abundances in sea water and sediments is now being carried forward. The mechanism of injection of REE into sea water will be studied. The differences in $^{143}Nd/^{144}Nd$ in various water masses (Piepgras *et al*, Earth and Planet Sci. Lett. *45*, 223–236 and Piepgras and Wasserburg, Earth and Planet Sci. Lett. *50*, 128–139 (1980)) is now being carried forward as an exploratory venture in order to determine the origin and chemical behavior of REE in the ocean and the potential use of $^{143}Nd/^{144}Nd$ as a tracer. The laboratory facilities for sample preparation and analysis are fully functional and will be available. Applicants should have training in oceanography and a good perspective on general physical oceanographic models.

Send resume and references to Professor G. J. Wasserburg, Lunatic Asylum, California Institute of Technology, Pasadena, CA 91125

Caltech is an equal opportunity-affirmative action employer (M-F-H).

EARTH SCIENCES

The Lamont-Doherty Geological Observatory of Columbia University invites scientists interested in any field of the earth sciences to apply for the following fellowships: two postdoctoral fellowships, each awarded for a period of one year (extendable to two years in special instances) beginning in September 1982 with a stipend of $22,500 per annum. Completed applications are to be returned by January 15, 1982. Application forms may be obtained by writing to the Director, Lamont-Doherty Geological Observatory, Palisades, New York 10964. Award announcements will be made February 28, 1982 or shortly thereafter.

The Observatory also welcomes applications from candidates for postdoctoral research associate positions in this discipline.

Faculty Positions
Space Physics and Astronomy
Rice University

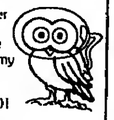
The Department of Space Physics and Astronomy of Rice University has two regular faculty openings, beginning in academic year 1982–83.

For one position, which is at the professorial level, preference will be given to experimentalists who are Principal Investigators for experiments on present or planned spacecraft missions. However, consideration will be given to other qualified candidates in the general areas of space physics and atmospheric science.

For the other position, which is at the assistant professor level, preference will be given to candidates with experience in space astronomy, although applications are solicited from specialists in any area of modern astrophysical research. It is also desirable, though not essential, that the candidate's research interests complement one or more areas of present astronomical research at Rice, such as planetary studies, stellar evolution and nucleosynthesis, gaseous nebulae, imaging and spectroscopy of galaxies, and computer image processing.

Applicants should send resumés and bibliographies to:

Professor A. J. Dessler
Chairman
Department of Space
Physics and Astronomy
Rice University
P.O. Box 1892
Houston, Texas 77001



Rice University is an equal opportunity, affirmative action employer

Geophysicist: North Carolina State University—Raleigh. The Department of Marine, Earth and Atmospheric Sciences is reopening the search to fill a presently available tenure track position in geophysics. Rank is at the Assistant or Associate professor level. A Ph.D. is required.

Primary responsibilities will include generating and conducting research programs as well as teaching graduate courses in geophysics. The department currently consists of 31 regular faculty members including 16 in the areas of geology and geophysics. Please send resume and names of three references to J. L. Langfelder, Head, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh, NC 27650. Deadline for receipt of applications is December 1, 1981.

North Carolina State University is an equal opportunity/affirmative action employer.

Faculty Positions: Earth Sciences. SUNY Stony Brook is seeking candidates for tenure track appointments in the Department of Earth & Space Sciences, with emphasis on active research experience and an interest in teaching graduate and undergraduate students. Rank and salary are dependent on experience and qualifications. Areas of specialization are open since we are looking primarily for high-caliber applicants, but preference will be given to applicants with research experience in one or more of the following: Structural Geology, Tectonophysics, Geophysics, Mineralogy, Petrology, Geochemistry, and Mineral Resources. Qualified persons should send resume to Prof. Gilbert N. Hanson, Department of Earth & Space Sciences, SUNY Stony Brook, Stony Brook, NY 11794

SUNY Stony Brook is an equal opportunity/affirmative action employer. AK9140 6.

Research Positions/Seismology. Applications are invited for two possible research positions in the Institute for Geophysics, University of Texas at Austin, an equal opportunity employer.

Both positions involve field work on seismograph networks in Latin American countries, analysis and interpretation of data acquired from these networks and related seismological studies in the Caribbean and South America.

One Ph.D. level and one B.S.-M.S. level positions are available. Salary for either position will be arranged depending on experience. Please send Resume and Bibliography to Tosimatu Matumoto, Institute for Geophysics, University of Texas at Austin, 700 The Strand, Galveston, Texas 77550.

Virginia Polytechnic Institute and State University: Senior Research Associate. Interesting and abundant research and publishing opportunities, including new University-owned MOSTO VIBROSEIS system, VAX 11/780 computer. Must have experience in theory and application of reflection seismology, and be interested in the application of reflection seismology to the solution of geologic problems.

Send resumés to: Dr. O. R. Wones, Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0796

The University is an equal opportunity/affirmative action employer

University of Kansas/Sedimentology/Structural Geology. The Department of Geology of the University of Kansas, Lawrence, Kansas seeks applicants for two tenure track appointments that will begin in the fall of 1982 or spring of 1983. Geologists who meet the requirements for these positions and who can begin work in January 1982, are also invited to apply. Duties include teaching in our introductory, undergraduate major, and graduate courses; supervising graduate student theses and dissertations; conducting original research; and providing service through administrative and professional activities. Appointment to either one of these positions is potentially at any academic rank, but one or the other or both will be filled at the assistant professor level. Applicants must have the Ph.D. in hand or expect to complete it by the end of the first year of employment at the University. Minimum salary at the assistant professor level is $23,000; salary for each position will be determined by rank and experience.

Position 1. *Sedimentology.* We will consider applicants in any branch of sedimentology, but those with interests in studying carbonate rocks, in diagenesis and sedimentary geochemistry, or in the relationships of sedimentation and tectonics are preferred. The applicant will be expected to cooperate with present faculty in offering courses at the undergraduate and graduate level that cover all aspects of the study of sedimentary rocks.

Position 2. *Structural Geology, Regional Tectonics, or Metamorphic Petrology.* The successful applicant will be expected to teach a basic undergraduate structural geology course, offer graduate courses or seminars in some areas listed above, plus cooperate with present faculty in offering other undergraduate or graduate courses in mineralogy, petrology, physical geology, or Precambrian geology. If no suitable candidates apply for this position, the department may recommend hiring two of the applicants for position 1.

In the event the top candidates are about equally qualified, preference will be given to applicants for one of the positions who have experience that will allow them to teach a modern course in petroleum and subsurface geology or to applicants who will participate in the Department's summer field geology teaching program.

Priority will be given to applications received by November 8, 1981. Applications will be accepted from qualified candidates until the positions are filled.

Applicants should send a letter of application, a resume, and names of three references to:

Anthony W. Walton
Department of Geology
The University of Kansas
Lawrence, Kansas 66045
(913) 864-4974

The letter of application should include a statement of current and planned research interests and of courses that the applicant feels qualified to teach.

An equal opportunity/affirmative action employer.

Director, Office of Programs and International Affairs. The Office of Research and Development, National Oceanic and Atmospheric Administration (NOAA), has announced the vacancy of Director, Office of Programs and International Activities, located in Rockville, Maryland. The Office of Research and Development is responsible for administering an integrated program of research, technology and advanced engineering development and transfer relating to the oceans, the Great Lakes, the U.S. coastal waters, the lower and upper atmosphere, and the solar and terrestrial environment to increase understanding of the environment and human impact thereon, and thus provide the scientific basis for improved services. The Director, Office of Programs and International Activities, oversees the coordinated development of policies, programs and budgets, and international activities within the Office of the Assistant Administrator for Research and Development. This is an exciting and challenging opportunity for an individual with demonstrated knowledge of (1) oceanographic, meteorological, environmental, physical and/or engineering sciences (including at least 24 semester hours in physical science and/or closely related engineering science at the college level or above), or (2) program analysis techniques and methods involving broad experience in scientific and technological programs related to the oceans or the atmosphere. A knowledge of U.S. policies on treaties and international multilateral and bilateral agreements is desirable.

SALARY: This position will be filled under the Senior Executive Service (SES). Salary could range from $47,585 to $50,112.50 per annum.

APPLICATION: Interested persons should send a U.S. Standard Form 171, Personal Qualifications Statement by October 9, 1981, to Mrs. Susan Clisar, Personnel Management Specialist, Office of Personnel, MB:PER11, NOAA, 6001 Executive Boulevard, Rockville, Maryland 20852.

The Department of Commerce, National Oceanic and Atmospheric Administration is an equal opportunity employer.

Structural Geology/University of Illinois at Champaign-Urbana. [Search reopened] The Geology Department is seeking a structural geologist for a tenure-track (assistant professor) faculty position. A Ph.D. is required. Salary open. The successful candidate will be expected to teach advanced undergraduate and graduate courses in structural geology and establish a research program. For equal consideration, applications, including the names of three referees, should be sent by February 1, 1982 to Dr. O. E. Anderson, Department of Geology, University of Illinois, 245 Natural History Building, 1301 West Green Street, Urbana, IL, 61801–2999, (217) 333-6713.

Position to be filled by September 16, 1982.

The University of Illinois is an affirmative action/equal opportunity employer.

Postdoctoral Position: Hydrologist/Soil Physicist. Research related to subsurface radioactive wastes storage in unsaturated fractured rock; assessment and prediction of water and solute transport. Salary $20,000 to $24,000 depending on qualifications. Position available October 1, 1981. Send resumé, transcript, and reprints of major publications to Dr. Daniel B. Evans, Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721.

Equal opportunity/affirmative action, title IX section 504 employer.

Division Chairperson. Applications and nominations are invited for the position of chairperson of the Division of Marine and Atmospheric Chemistry for the Rosenstiel School of Marine and Atmospheric Science. Applicants should have achieved significant research accomplishments in environmentally oriented chemistry. Previous administrative experience considered but is not required. Applications and three letters of recommendation should be sent to: Dr. Frank Millero, Chairman of Search Committee, Division of Marine and Atmospheric Chemistry, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149–1098.

The University of Miami is an equal opportunity/affirmative action employer.

Hydrologist. The State University of New York at Binghamton is re-opening its search for an assistant or associate professor of hydrogeology to join a department already active in several areas of water studies. The applicant should have a PhD and experience in mathematical techniques, as well as field experience. The applicant will be responsible for instruction at both the undergraduate and graduate levels and for developing a program of research. The position will be filled in September 1982.

Please send application, including the names of referees, to Thomas W. Donnelly, Chairman, Department of Geological Sciences, State University of New York, Binghamton, New York 13901.

We are an equal opportunity/affirmative action employer.

Senior Faculty Position: Meteorology. Applications and nominations are invited for a senior faculty position in meteorology, at the University of Utah. Eligible applicant will also be considered for chairperson of the department. Candidates must possess a Ph.D. in meteorology or a related discipline. Applicants should have teaching and research experience and be interested in participating in both the graduate and undergraduate programs. Applicants should submit curriculum vitae and names of three professional references to:

Dr. Jan Peegle
Search Committee
Department of Meteorology
University of Utah
Salt Lake City, Utah 84112

Deadline for applications November 30, 1981.
The University of Utah is an affirmative action/equal opportunity employer.

Faculty Position: Environmental Engineering. Beginning January or September 1982. The position requires undergraduate and graduate teaching and sponsored research activities in the areas of water quality control and water resources. An earned doctorate is required and at least one degree in civil engineering is preferred. Rank will be at the assistant professor level and salary will depend upon qualifications. Apply to: Dr. Lester A. Hoel, Chairman, Department of Civil Engineering, University of Virginia, Charlottesville, Virginia 22901.

An affirmative action/equal opportunity employer.

SERVICES

GEOTHERMAL DEPOSITS. If you are financing, planning, designing, exploring, drilling, or digging in connection with any form of energy, you need this complete, up-to-date book about the world's geothermal-energy deposits. Includes production and reserves for areas and wells. Hardcover, 8 x 9 inches, 292 pages. Table of contents, drawings, index, references, 1978. $84, Taitch Associates, 120 Thunder Road, Sudbury, MA 01776.

ANNOUNCEMENTS

53rd Annual Meeting, Seismological Society of America. Abstract deadline September 25 for 53rd Annual Meeting of Eastern Section, Seismological Society of America, Oct. 26–28, 1981, Milwaukee, Wi. (R. W. Taylor, Univ. of Wisconsin-Milwaukee, Dept. of Geological Sciences, Milwaukee, WI 53201).

STUDENT OPPORTUNITIES

Graduate Study in Space Physics & Astronomy

Rice University is pleased to offer Fellowships for entering graduate students in the Department of Space Physics and Astronomy. Exciting research is underway in the fields of theoretical and experimental space plasma physics, magnetospheres of the earth and planets, atmospheric and ionospheric physics, laboratory studies of Rydberg atoms, laser research, space solar power studies, and astronomy and astrophysics.

The fellowships for first year students presently are $4545 tax/free for 9 months, plus tuition, and involve only 4–5 hours tutoring, grading, or instructing per week for four semesters. Research assistantships for summers and subsequent years are generally available at $650 per month. Students with exceptional undergraduate records and GRE scores are eligible for an additional $1000 Presidential Recognition Award. Raises are expected for next year.

Address inquiries to: Dr. Patricia Reiff, Assistant Chairman, Department of Space Physics and Astronomy, Rice University, 77001.

Earth Sciences Assistantships and Fellowships. Research assistantships and fellowships are available to graduate students in the earth sciences from the Columbia University Department of Geological Sciences. The awards cover tuition and fees, and provide a yearly stipend of between $6400 and $8180.

Research is carried out at affiliated institutions including the Lamont-Doherty Geological Observatory, the Goddard Institute for Space Studies, and the American Museum of Natural History. Research topics available to students reflect the interests of the more than 300 Ph.D.-level scientists at these institutions and span virtually every area of the earth sciences.

The department encourages applications from students with an undergraduate degree in any of the natural sciences or engineering. For additional information please contact Ms. Mie Lee, Department of Geological Sciences, Columbia University, Lamont-Doherty Geological Observatory, Palisades, New York, 10964.

AGU

AGU Selects Science Fellow

George H. Shaw, an associate professor in the geology and geophysics department at the University of Minnesota, is the 1981–1982 AGU Congressional Science Fellow. The fifth person to be selected for the program, he recently began his 1-year term on Capitol Hill.

Rock and mineral physics (including physical properties of minerals under high pressure, phase relations, and polymorphism) are Shaw's main research interests. His most recent research includes studies on the elastic properties of polymorphic materials under high pressure and moderate temperature, elastic behavior in solid-solid equilibrium systems, extrapolation of elastic properties of mixtures at high pressure, the equation of state of alkali metal liquids, and calculations on the energy of planetary core formations. He is also interested in the hydrology of karst terrains and the impact of human activity on groundwater quality in such areas.

Shaw has been an associate professor since 1979; before that he was an assistant professor for 5 years. Prior to receiving his Ph.D. in geology from the University of Washington in 1971, he served 1 year as a research associate in geophysics and geology at Washington. He was a postdoctoral fellow at the University of Edinburgh for 1 year and served as an assistant professor at the Florida International University for 2 years.

The AGU Congressional Science Fellow program is one of about 20 society programs that make up the American Association for the Advancement of Science Congressional Science and Engineering Fellows Program. This program is designed to involve fellows in making public policy within Congress by working either on the staff of a member of Congress, for a congressional committee, or in some other area of Congress.—*BTR*

Scholarship for Women in Atmospheric Sciences

The fourth annual June Bacon-Bercey Scholarship for Women in Atmospheric Sciences has been awarded to Becky Ross, a first-year graduate student in atmospheric science at Purdue University.

Ms. Ross is from Waterloo, Iowa, and received her bachelor's degree in physics from Bryn Mawr College in 1980. For her master's degree she is investigating small-scale structure in the mesoscale cellular convection with a research group under E. M. Agee that will, it is hoped, indicate more clearly how the final steady state convection is formed. She plans to obtain a Ph.D. and continue in research, either academic or private.

This scholarship is awarded annually to a woman who is pursuing a degree in the atmospheric sciences, and it is given on the basis of academic achievement and promise to a student who intends to make atmospheric sciences her career.

The scholarship is made possible through a gift from June Bacon-Bercey, a noted meteorologist, who, during her career, served as an oceanographer, a weather analyst for the National Meteorological Center, a radar meteorologist for the New York City Public Forecast Office, an engineer for the Fort Instrument Corporation, and as a consultant with the Atomic Energy Commission. She is currently with NOAA.

Sponsors of 1981 New Members

Two hundred eighty-four new members were elected between July 1 and August 5, 1981. The AGU members who sponsored them are listed below.

Twelve Members: A. Ivan Johnson.

Eleven Members: S. W. Lohmen.

Four Members: David H. Eggler.

Three Members: G. F. Davies.

Two Members: Rodney Baltiz, James G. Blencoe, E. G. Bombolakis, Richard D. Brown, Leonard F. Burlage, Robert L. Carovillano, David S. Chapman, Norman Z. Cherkis, R. M. Clowes, Joshua D. Cocker, Robert Cos, Stanley N. Davis, Victor E. Delnore, Harold H. Demarest, Jr., Robert S. Detrick, Jr., David Elliott, Robert M. Ellis, David L. Freyberg, Trevor Hart, George R. Holdren, Jr., Bryan L. Isacks, Ian S. F. Jones, Robert W. Kay, Leonard F. Konikow, R. Dale Landon, Joe M. Lara, Roger L. Larson, Michael T. Ledbetter, Philip E. Long, Stearns A. Morse, Peter Olson, Barry Parsons, Alan R. Rice, Arthur W. Rose, Janet A. Schramke, Robert B. Smith, Edward Stolper, Robert L. Street, John H. Trefry, Arnold Verruijt, David Walker, Y. C. Whang, Gerlad Williams, Peter M. Wolcashyn, Mark T. Woods, Xue-pu Zhao.

One Member: Mahs Abdalla, John R. Adams, T. J. Ahrens, Thomas D. Aitken, Daniel Lee Albritton, L. T. Aldrich, Shalton S. Alexander, Claude J. Allegre, John M. Allen, Robert C. Aller, Omer Alptekin, Ian G. Alterman, Don L. Anderson, Charles A. Appel, Richard Lee Armstrong, Arthur John Askew, Barry Keen Atkinson, Raymond E. Arvidson, Alice K. Babcock, L. Joseph Bachman, Edward Baker, Subir K. Banerjee, H. L. Barnes, Leo R. Beard, John C. Behrendt, John W. Belcher, Peter M. Bell, Kathe K. Berline, Nani G. Bhowmik, Kevin T. Biddle, Robert B. Biggs, Thomas J. Birmingham, David D. Blackwell, William E. Bonini, Jean Bonnin, George H. Born, M. H. P. Bott, Edward M. Brooks, Ken Bruland, Harry Bryden, Van Burbach, William J. Burks, William C. Burnett, C. Wayne Burnham, J. Byerlee, Roger G. Burns.

George R. Carignan, Herbert C. Carlson, William D. Carlson, Lawrence M. Cathles, Shin Chang, Shenn Yu-Cheo, Clement G. Chase, Chuen H. Chen, Ralph T. Cheng, John A. Cherry, Bernard H. Chovitz, Demos C. Christodoulidis, Adam Chrzanowski, Ralph J. Cicerone, Paul F. Ciesielski, Thomas A. Clark, Peter M. Clifton, Joel Cline, Koren Kluger Cohen, Jared Cohen, Stewart A. Collins, Kevin Coppersmith, Charles E. Corry, Edward H. Cougtran, Ronald L. Cramer, Paul Crutzen, F. A. Dahlen, Donald R. Davis, J. Peter Davis, T. Neil Davis, David J. Demaster, John F. Devere, Richard N. Devries, Diane Doser, Bruce C. Douglas, Michael A. Dungan, J. W. Dungey, Bernard R. Durney, Kazim Ergin, Daniel D. Evans, Ulben Ezen.

Richard G. Fairbanks, John L. Fanselow, Donald T. Farley, R. N. Farvolden, J. J. Fawcett, John G. Ferris, Jack Fishman, George W. Fisher, Charles N. Flagg, Marianne Fleischmann-Maki, Jeffrey M. Forbes, L. N. Frazer, Fred A. Frey, James P. Friend, E. O. Frind, Albert L. Frisillo, Chil Frohlich, John A. Fornshell, Naoshi Fukushima, John J. Gallagher, Jr., Michael Garcia, Richard W. Garvine, Roland W. Gerwood, Jr., John William Geissman, John G. Gergen, Ronald J. Gibbs, Carl H. Gibson, Bruno J. Gilelli, Jeffrey A. Gilman, Kenneth A. Goettel, Edward D. Goldberg, Louis I. Gordon, Richard G. Gordon, Neil R. Goulty, Crockett Grabbe, T. E. Graedel, Donald L. Gral, E. K. Graham, Jr., Louis E. Greco, Glenn Greenland, Noal P. Grais, Thomas C. Grenfell, David B. Grove.

David R. Haddock, Warren A. Hall, H. C. Halls, Douglas C. Hamilton, William A. Harenberg, John C. Harrison, James Fred Hays, Gary R. Hecox, Ismael Herrera, Thomas A. Herring, Robert B. Herrmann, Donald G. Hill, Charles D. Hollister, Norden E. Huang, Donald M. Huntan, Ian Jackson, John R. Jasperse, Ansel G. Johnson, Torrence V. Johnson, Malcolm Johnston, Blair F. Jones, W. Linwood Jones, Thomas H. Jorden, Alan L. Kafka, Hiroo Kanamori, Samuel Katz, M. J. Keen, G. R. Keller, Ozer Kaner, Robert C. Kessler, Dana R. Kester, John William King, Robert W. King, Paul Kintner, Stephen Kirby, Carl Kisslinger, George Devries Klein, Wull Klohn, Charles R. Knowles, Kenneth P. Kodama, Louis C. Kovacs, Theodor Kray, Leo Kristjansson, Ota Kulhanek, George Kukle.

Arthur H. Lachenbruch, D. R. Legeson, Evangelos Legios, Robert A. Lamontagne, William M. Landing, Robert A. Langel, Charles A. Langston, Kathryn Lepham, Antonio C. Lasaga, Alan Lazerus, Frederick K. Lepple, Robert C. Liebermann, Mervin Lilley, Allen Linda, Irving W. Lindenblad, Marilyn M. Lindstrom, Ronald J. Lipp, Joes Seixes Lourenco, William D. MacDonald, Thomas Maddock III, David R. Maidment, Thomas F. Malone, Ho-Kwang Mao, W. G. Marlette, Bruce Marsh, Philip Marsh, Glenn M. Mason, Steven T. Massie, John C. Maxwell, Alexander R. McBirney, William R. McCann, Julian McCreery, Jr., Michael J. McEachern, Carl McElwee, Mack McFarland, J. T. McGoogen, Robert E. McGuire, William F. McKenzie, William B. McKinnon, Ronald T. McLaughlin, Dennis McQuillan, H. J. Malosh, Karl O. Millahn, Alexis N. Moiseyev, Christopher N. K. Mooers, Michael M. Mooredien, Eldridge Mooros, H. J. Morel-Seytoux, Paul Morgan, Stephen Morris, Sharon Moshar, David Mountain.

Sechio Nabetani, Robert M. Nelson, Richard W. Newton, Mansour Niezi, Adnan Niazy, Dwight R. Nicholson, Carl S. Nilsson, G. Nolet, Denis Norton, Otto W. Nuttli, Dale J. Nymen, A. R. Ochadlick, Jr., David H. Oppenheimer, John Orcutt, Steven S. Orlet, Gerald T. Orlob, Richard E. Orville, D. A. Papanastassiou, Mervyn S. Paterson, Wayne D. Pennington, Donald K. Perovich, David H. Peterson, Hans-Olet Pfannkuch, David Piari, Leonard J. Pietrelesa, G. F. Pinder, Walter L. Pilant, Dean C. Presnell, Peter F. Prodan, Philip D. Rabinowitz, Robert M. Ragan, Sundar Rajan, V. Ramenathen, Richard H. Rapp, Jaan-Cteuda Rossam, William S. Reabrugh, D. Reos, Joseph L. Reid, J. M. Rhodes, Michael C. Roberts, Peter Robinson, Robert L. Rothmon, Jean Rousselle, Robert F. Roy, Thomas C. Royor, C. T. Russell, R. Doncaster Russell, Malcolm J. Rutherford, Ernest H. Rutter, James W. Ryan.

Robert A. Saar, I. Solwyn Sacks, T. Sakou, Jason Saleohy, Edward A. Sammoi, Thomas B. Santord, John H Sass, William U. Sevage, Richard Scantol, O. A. Schaeffer, J. G. Schilling, Raymond W. Schmitt, Otto Schneider, Jalrsy P. Schubert, Karl W. Schulor, David P. Schwartz, Charles B. Sclar, John G. Sclater, Donald R. Sealy, John M. Shetar, Lamott Shulaby, James R. Sharber, Thomas J. Shay, M. A. Shea, Clifford Shock, Robert W. Simpson, John M. Sinton, Richard L. Skoggs, Don F. Smart, J. Samuel Smart, Louis D. Smith, Jr., Richard A Snay, Joseph W Snow, Sonn C. Solomon, Shully I. Solomon, David John Southwood, Frank J. Spiero, Mary Ann Spieth, B. Srinivasan, Surat P. Srivastava, Don W. Steeples, Seth Stein, Roland C. Steinor, James Alan Steppe, Robert S Sternberg, Yaron M. Sternberg, John C. Stormer, Jr., Robert G Strom Alan E. Strong, William D Stuart, John S Sumner, Verner E. Suomi, John Suppe, Chandler A Swanberg, Lynn R Sykes.

Tsumtomu Tamao, Kazuo Tanake, Donald H Tarling, Ronald C. Taylor, Mitsunobu Tatsumoto, Herman H. Thomas, Kurt O. Thomsen, Clifford H. Thurber, George R. Tilton, M. Nati Toksoz, Laung Tsang, Jan Tullis, Terry E Tullis Alcee N. Turcan, Jr., Avdhesh K. Tyagi, James A Tyburczy, Urho A. Uotila, Dava Updegraff, W. R. Van Schmus, Kenneth L. Verosub, Umberto Villante, N. J. Vlaar, Peter R. Vogt, Bernard Vonnegut, William B. Wadsworth, James C. G. Walker, William C. Walton, Peter J. Wangersky, Robert L. Warasila, G. J. Wasserburg, Robert S. Weinbeck, Christopher S. Walch, David E. Wells, G. F. West, George W. Wetherill, Lawrence H. Wight, Richard T. Williams, Douglas S. Wilson, Robert P. Wintsch, George L. Withbroe, Michael Woldenberg, John A. Wolte, Kenneth M. Wolgemuth, I. J. Won, Shue Tuck Wong, M. K. Woo, Nicholas B. Woodward, Sung Jin Yang, David A. Yuen, Isidore Zietz, Alberto Zirino.

Meetings

GSA Symposia: Call For Papers

A call for papers has been issued for two symposia slated for the Rocky Mountain Sectional Meeting of the Geological Society of America. The two symposia, 'Structure and Tectonic Evolution of the Fold-and-Thrust Belt' and 'Geologic Aspects of the Disposal of High-Level Nuclear Waste in Igneous Rocks,' will be held in Bozeman, Mont., on May 7–8, 1982.

The 1-to-2-day symposium on fold-and-thrust belts will be subdivided into three general categories: structural geology of the western Montana fold-and-thrust belt; tectonics and regional geophysics of the northwestern United States; and fold-and-thrust belt. Submit one copy of the abstract by November 15 to the symposium chairman: David Lageson, Department of Earth Sciences, Montana State University, Bozeman, MT 59717.

The one-half-to-full-day symposium on nuclear-waste disposal will emphasize the hydrogeologic, geochemical, mineralogic-petrographic, structural, and thermal-mechanical aspects of the problem. Papers that treat the basic science of high-level nuclear waste disposal in igneous rocks will be preferred to project progress reports. Send one copy of the abstract to Klaus Keil, symposium chairman, Department of Geology and Institute of Meteoritics, University of New Mexico, Albuquerque, NM 87131; deadline is November 15.

Space Simulation Conference

A call for papers has been issued for the 12th Space Simulation Conference, entitled 'Shuttle Plus One: A New View of Space.' The purpose of the conference, to be held in Pasadena, Calif., from May 17 to 19, 1982, is to provide a forum for the review and the exchange of information and ideas on current space simulation technology and closely related disciplines. Projections for testing requirements and technology development for the coming decade also will be discussed.

The conference is soliciting papers covering space simulation facilities, space program trends, remote sensing, thermal simulation, shuttle flight results, space physics, spacecraft testing, and unique facilities.

Three copies of proposed abstracts should be sent to the technical program chairman, John W. Harrell, 144/216, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109. Authors should attach a cover letter, which states the complete paper title; the author's name, affiliation, address, and telephone number. All papers must be unclassified and not published previously. The abstract deadline is October 1.

The conference is hosted by the Institute of Environmental Sciences (IES) and is supported by the American Institute of Aeronautics and Astronautics, the American Society for Testing and Materials, and NASA/JPL.

For additional information, contact IES, 940 East Northwest Highway, Mt. Prospect, IL 60056 (telephone: 312-255-1561). ⊠

AGU CHAPMAN CONFERENCE

RAINFALL RATES

April 27–29, 1982 Urbana, Illinois

Convenor: D. M. Hershfield

Sessions planned:

Atmospheric physics as related to rainfall processes.
Measurement: mass (tipping bucket), photoelectric, magnetic, and remote methods.
Models: physical, mathematical, and statistical.
Applications: point, area, quasihorizontal path, surface, troposphere, and stratosphere.

Call for papers published in EOS, July 14. Abstract deadline: December 21, 1981.

Seismology

6910 Explosion Seismology
CRUSTAL TRAVEL TIME INVERSION OF EXPLOSION SEISMOLOGY DATA FROM THE EASTERN SNAKE RIVER PLAIN, IDAHO
W. Priestley and J. Orcutt (Geological Research Division (A-025), Scripps Institution of Oceanography, La Jolla, CA 92093)
We have inverted travel time data from seismic reflection profiles within the Snake River Plain, a volcanic-tectonic depression in southern Idaho, for crustal and uppermost mantle compressional velocity structure. The data in the vicinity of the youngest, northeastern volcanics in the depression require the presence of a significant low velocity zone in the lower crust at depths between 20 and 40 km in order to explain the presence of a caustic at short ranges resulting from the crust-mantle transition. Data to the west are more compatible with a model in which the velocity increases monotonically with depth. These observations are consistent with other data including the progressively lower crustal conductivity toward the northeast, the dried progression of volcanics from the southwest to the northeast at a rate of about 2 cm/yr, the anomalously high P_n velocity (8.3 km·s^{-1}) and surface wave dispersion studies. The velocity reversals required by the data associated here and surface wave studies in the area are almost certainly related to elevated temperatures in the lower crust which approach or exceed the solidus of the deep crustal composition. The entire crustal section in the eastern Snake River Plain is characterized by very high velocities and can be represented by models with no first-order discontinuities with the possible exception of the Moho or crust-mantle transition.
(J. Geophys. Res., Bol, Paper 10L251

6910 Explosion Seismology
THE CORRECTION FOR THE TRAVEL TIME EFFECTS OF SEA-FLOOR TOPOGRAPHY IN THE INTERPRETATION OF MARINE SEISMIC DATA
A.E. Ruby (Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543)
Problems associated with the application of topographic corrections to deep ocean marine seismic data are discussed. Synthetic travel time data are used to show that corrections for the delay time introduced by the water column may be ineffective corrections for the true water path. Water path corrections place the source at the very entry point to the seafloor and require no assumptions concerning the structure under investigation and obviate the correct distribution of data with range. The water path correction can be most advantageously applied during the stacking operation that superposes the observed data and intercept time-slowness space. Then it then no requirements to data determinations of slowness and for refraction analysis. Synthetic results for refraction data may be transposed to the surface with complete objectivity. Water path corrected times from different locations may then be compared in the sure knowledge that any observed differences are due to real structural changes and not to topographic correction errors or to invalid assertions of lateral homogeneity.
(J. Geophys. Res., Bol, Paper 10L329

5120 Phenomena related to earthquake prediction
A CASE OF CORRELATION BETWEEN BH ANOMALIES AND SEISMIC ACTIVITY ON A VOLCANO (VULCANO ISLAND, SOUTHERN TYRRHENIAN SEA)
L. Lo Forno, F. Ciaparini (Istituto di Geologia e Geofisica, Universita di Napoli, Italy); M.S.M. Mantovani, V. Marini, G. Capaldi, V.T. Gomes and R. Pece
Factor of 10 increase in the Rn concentration in a shallow aquifer forerunning a shallow seismic swarm was observed on the island of Vulcano (Aeolian Island arc). The precursor is precisely preceded by about one month the seismic swarm, which had a cumulative magnitude of 3.8. That the lag between the two phenomena is much longer than expected, given the small energy released by the swarm. The observed precursor may not have a direct cause-effect relationship, but they both can be a consequence of a single phenomenon. (Earthquake prediction, Radon, volcano).
(J. Geophys. Res. Lett., Paper 81L094

5120 Phenomena related to earthquake prediction
RADON CONTENT OF GROUNDWATER AS AN EARTHQUAKE PRECURSOR: EVALUATION OF WORLDWIDE DATA AND PHYSICAL BASIS
L. Knutson (Department of Geological Science and Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York 10964) USA)
The properties of worldwide data set of Rn radon (Rn^{222}) anomalies (the frequency of occurrence, the precursor time interval, and the distribution of peak amplitudes) are correlated with earthquake magnitude and epicentral distance. These anomalies were reported as precursors to earthquakes in the U.S., U.S.S.R., China, Japan, and Italy. Although the data set is incomplete and limited by unsystematic deficiencies, several consistent patterns emerge.
Radon anomalies from different tectonic regions show similar patterns. The radon anomalies occur at greater epicentral distances for earthquakes of the larger magnitude. Anomalies preceding large earthquakes (M ≥ 6) are frequently observed at distances of 100 to 500 km. These distances are larger than several times the rupture dimensions of the future earthquakes. The time from the onset of an anomaly to the time of the earthquake (the precursor time) increases with magnitude but decreases with distance between epicenter and radon station. In addition, radon anomalies are observed more frequently prior to large earthquakes than prior to small ones, indicating that the preparation zone increases in size as magnitude increases. The peak amplitude does not scale with magnitude but has a consistent pattern with epicentral distance in that the larger, the earthquake magnitude the farther away the largest amplitudes tend to occur. The preparation size of the earthquake where the anomalies occur forms an almost continuous anomalous zone that expands with time away from the future rupture zone. The outer radius of this zone reaches with the earthquake magnitude.
Model calculations, indicate that strain rates of at most 10^{-6} to 10^{-7} strain exceed radon anomalies. If those strains are divided by the appropriate precursor time, tectonic strain rates from 10^{-7} day^{-1} to 10^{-8} day^{-1} are obtained. Such small strains and strain rates suggest that is not caused neither mechanical crack-growth induced by diffusancy nor mechanical coupling between pore pressure and the rock matrix caused the anomalies. Large changes in the stress state of the local stress field, however, could occur and affect the local strain intensity factor. Since changes in tectonic stress intensity factor can result in stress corrosion, the occurrence of radon anomalies is attributed to slow crack-growth controlled by stress corrosion in a rock matrix saturated by groundwater. (Radon anomalies, earthquake prediction, stress corrosion, stress corrosion).
(J. Geophys. Res., Bol, Paper 10L247.

6950 Seismic Sources
A STOCHASTIC FAULT MODEL, 2. TIME-DEPENDENT CASE
D. J. Andrews (U.S. Geological Survey, Menlo Park, California 94025)
A random model of fault motion in an earthquake is formulated by assuming that the slip velocity is a random function of position and time truncated at zero, so that it does not have negative values. This random function is chosen to be self-affine, that is, on change of length scale, the function is multiplied by a scale factor but is otherwise unchanged statistically. A snapshot of slip velocity at a given time resembles a cluster of islands with rough topography; the final slip function is a smoother island or cluster of islands. In the Fourier-transform domain, shear traction on the fault equals the slip velocity times an impedance function. The fault limits this impedance function not a pole at zero frequency implies that traction and slip velocity cannot have the same spectral dependence in space and time. To describe stress fluctuations on the order of 100 bars when averaged over a length of kilometers, and on the order of tiloBars at the grain size, shear traction must have a one-dimensional power spectrum in space proportional to the reciprocal wavenumber. Then the one-dimensional power spectrum for the slip velocity is proportional to the reciprocal wavenumber squared, and for slip to its cube. If slip velocity has the same power-law spectrum in time as in space, then the spectrum of ground acceleration will be flat (white noise) both on the fault and in the far field. (Random seismic sources, high-frequency ground motion, self-similarity, self-affinity).
J. Geophys. Res., Bol, Paper 10L251

6960 Strong motion and shock waves
SHOCK METAMORPHISM IN THE VREDEFORT COLLAR: EVIDENCE FOR INTERNAL SHOCK SOURCES
R.A. Lilly (Bernard Price Institute of Geophysical Research, University of the Witwatersrand, Johannesburg, South Africa, 2001)
Shock metamorphic microstructures in the vredefort collar include planar features, crystallographically controlled cleavage, crystallographically controlled twins and mosaic extinction. In addition, several recrystallization textures are developed in the quartzites of the collar and quartz grain distribution for both primary and recrystallized quartz grains are ranked. The degree of recrystallization decreases away from the core-collar contact. Two events of shock deformation have been identified in the collar and, using planar feature orientations, shock pressures have been estimated using the technique of Robertson (1975). The first shock (P1) subjected the lower most Witwatersrand rocks to shock pressures of about 150kb and the uppermost beds to pressures of about 60kb. Following a period of successive recrystallization of the quartzites came the second shock event (P2) which was weaker than the first and subjected the lowermost strata in the collar to pressures of between 25kb and 35kb. The P2 event has been shown to be separated in time from the P1 event. The results are used to show that the shock sources were pre-basin within the earth and that the Vredefort ring structure has formed as a result of endogenous processes rather than hypervelocity meteorite impact. Shock metamorphic microstructures, fine structures, Witwatersrand sediments, meteorite impact (J. Geophys. Res., Bol, Paper 10L49

6970 Structure of the crust and upper mantle
SEISMICITY OF THE PORTLAND, MANITOU, MERGE (ACCRETIONARY PRISM)
A. T. Chen (Institute for Geophysics, Univ. of Texas at Austin, Austin, Texas 78712) C. Frohlich and S. V. Latham
Three different types of seismic data have been examined for seismic events occurring within the zone called the accreted wedge or forearc province wedge that underlies the inner trench wall of some arcs. These types of data are: (1) teleseismically-recorded earthquakes that have been reported in the literature as occurring in major Arc-trench regions. These events fall in deep-and shallow shock earthquakes occur within the accreted wedge because the uncertainty of focal depth usually far exceeds the depth dimension of the accreted wedge. These data include many tsunamigenic earthquakes. (2) Local earthquakes located by combined ocean bottom seismograph and land networks in the arc-trench region in the New Hebrides and the central and eastern Aleutian Trench. Some of the more reliable of these hypocenters lies within the accreted wedge.
(3) S-P intervals measured at stations on islands located on the outer ridge or at OBS stations on the forearc marginal wedge. These data do not show the existence of events occurring within the accreted wedge. These locations reported in this paper which are within or close to the seismic network contain some of the first reliably located shallow events ever reported in convergent margins of island arcs. The absence of seismic activity within the accreted wedge in any island arc that we studied suggests that the deformation evolved in this region occurs aseismically.
J. Geophys. Res., Bol, Paper 10L330

6970 Structure of the crust and upper mantle
CRUSTAL STRUCTURE OF THE EASTERN SNAKE RIVER PLAIN FROM RAY-TRACE MODELING OF SEISMIC REFRACTION DATA
M.A. Sparlin (Department of Geosciences, Purdue University, West Lafayette, Indiana 47907) L.W. Braile, R.B. Smith
Ray-trace travel-time modeling of the seismic refraction record sections for a profile from near Soda Springs, Idaho to near McKay, Idaho was used to derive a crustal model across the eastern Snake River Plain (ESRP). The derived crustal model is consistent with the velocity structure interpreted from a profile along the axis of the ESRP. The interpretation also indicates that significant lateral inhomogeneities occur in the upper crust beneath the ESRP when compared with the upper crust beneath the adjoining Northern Rocky Mountain and Basin and Range provinces. The most prominent features of the crustal structure inferred by the ray-trace modeling are as follows: (1) The northern most margin of the eastern SRP are modeled as a fault structure, downthrown on the SRP side (SE) with an offset of greater than 4 km. The southwest margin, conversely, appears to be downwarped with possible minor faulting. Paleozoic sedimentary rocks are present beneath the Cenozoic volcanics of the ESRP possibly to and beyond 40 km from the southeastern margin of the ESRP near Blackfoot, Idaho. (2) The modeling indicates no significant increase in the depth to the top of the lower-crustal layer near the margins of the ESRP. (3) An 'intermediate' 6.5 km/sec layer occurring beneath the ESRP, interpreted from a refraction profile located along the axis of the ESRP, was found to be localized within the ESRP margins. This layer is interpreted as a pervasive intrusive of higher velocity material from the upper mantle into the highly fractured upper-crustal layer in this region. (4) A density model of the crust across the eastern SRP was prepared with the densities selected using the interpreted seismic velocities as a constraint. The gravity field calculated from this model resulted in a good match to observed gravity data over the eastern Snake River Plain. (Crustal structure, eastern refraction, ray-trace modeling).
J. Geophys. Res., Bol, Paper 10L355

6970 Structure of the crust and upper mantle
THE YELLOWSTONE-SNAKE RIVER PLAIN SEISMIC PROFILING EXPERIMENT: CRUSTAL STRUCTURE OF THE EASTERN SNAKE RIVER PLAIN
L.W. Braile (Department of Geosciences, Purdue University, West Lafayette, Indiana 47907) R.B. Smith, J. Ansorge, M.R. Baker, M.A. Sparlin, C. Prodehl, M.M. Schilly, J.H. Healy, St. Mueller, K.H. Olsen
Seismic refraction profiles recorded along the eastern Snake River Plain (ESRP) in southwestern Idaho during the 1978 Yellowstone-Snake River Plain cooperative seismic profiling experiment are interpreted to infer the crustal velocity and interface (P) structure of the ESRP. Travel-time and synthetic seismogram modeling of a 260 km reversed refraction profile as well as a 100 km detailed profile indicate that the

6970 Structure of the crust and upper mantle
ANISOTROPIC GRADIENTS IN THE UPPER MANTLE
Jan Germany (Department of Oceanography, University of Washington, Seattle, WA 98195)
Pn amplitudes in some widely spaced sets of oceanic crust are greater in the line the slant than in the slow direction. Pn amplitudes increase with the predicted amplitude behavior for simple head waves, but can be explained by an increase in anisotropy with depth. It appears that these gradients are due to increasing olivine crystal orientation, although changes in the relative abundance of two anisotropic minerals with not variable orientation could also account for the observations. Depth variation of orientation does not probably indicate very high temperature gradients at the Moho. This would imply a substantial amount of convective heat transport in the whole oceanic crust near mid-ocean ridges. (Anisotropy, Moho structure, surface refraction).
Geophys. Res. Lett., Paper 11L252

6990 Instruments and Techniques
AMPLITUDE AND PHASE EQUALIZATION OF SEISMOGRAMS FOR MULTIPLE SEISMOGRAM RECORDING SYSTEMS SUCH THE YELLOWSTONE-SNAKE RIVER PLAIN SEISMIC REFRACTION EXPERIMENT
M.R. Baker (Department of Geosciences, Purdue University, West Lafayette, Indiana 47907) L.W. Braile and R.B. Smith
A correlation filter theory method for the normalization of the instrument responses of several seismograms is presented. In this method, an inverse filter is derived by consideration of the seismometer/recorder characteristics which may be applied to a given seismogram to convert its system frequency response to that of a reference system. Inverse filters are derived for the seismographs used on the 1978 Yellowstone-Snake River Plain seismic profiling experiment. It is shown by application to these data that the inverse filters are effective in amplitude normalization and that their use allows improvement in the amplitude and waveform character of seismic record sections. (Seismograph, frequency response, inverse filter, normalization)
J. Geophys. Res., Bol, Paper 10L266

Tectonophysics

6830 Convection currents
TOPOGRAPHY MARKED BY LOW-VELOCITY ZONES AT BOUNDARIES OF REMOVED PLATE THICKNESS IN THE INDIAN OCEAN
C. Scheidegger and P. Talwani (Department of Earth & Planetary Sciences, University of Miami, Coral Gables, Florida 33124)
Profiles of travel times of the Earth's total crust and uppermost mantle compiled for the Indian Ocean, the Southeast Pacific Rise, the Nazca plate, and the Cocos plate are used to derive two-dimensional models of a depleted upper mantle and an underplate. A lower mantle low-velocity layer with a steady thermal gradient underlies the upper and lower mantle. Separation of the depleted lower mantle and an underplated upper mantle to match the observations of surface heat flow and mantle viscosity, the convection on the shallow side of ridges, the upper mantle legends in the oceanic crust in front of the Nazca plate, the lower crustal layers with thicknesses comparable to that of the surface thermal boundary layer, and the nearly flat-lying, subcrustal low-velocity boundary layer is limited by the relationship between the lithospheric temperature and the partial melting. The temperature at which melt is transferred into the lithosphere is controlled by the solidus of the upper mantle material. The upper mantle velocities, the thickness of the thermal boundary layer at the lower mantle as well as the upper mantle and crustal thicknesses, which we considered, were of high reliability.
(Geophys. Res. Lett., Paper 11L)

6130 Heat Flow
SOME REMARKS ON THE THERMAL CONDITIONS IN RIFTAL STRUCTURES
Albert T. Wood (Department of Geology, University of Illinois, Urbana, Illinois 61801)
A simple model has been developed to study the thermal consequences of rifts, which relate the geological process to surface heat flow and gravity. Assuming onset a finite line heat source, a period of plate velocity, rifts beneath the oblique angle Reykjanes Ridge and Iceland are found to be transient, calculated results indicate that the depth of thermal perturbation of a rift is approximately proportional to plate velocity. Thermal effects will penetrate deeper into a plate for longer ridges if the ridge axis is parallel to the direction of plate motion. Heat flow at depth of thermal disturbance is found to be independent of ridge length if rifts are parallel to plate motion direction. Thermal effects of rifts, ridges, oblique, moving heat sources.
(Geophys. Res. Lett., Paper 11L111

6130 Heat Flow
BOUNDARY FORCES AND PLATE VELOCITIES
D.L. Carlson (Department of Geophysics, Stanford University) A. Gilman (Department of Geology, Occidental College, Los Angeles, California 90041)
The notion that plate motions result from forces associated with the boundaries of lithospheric plates underlies a tremendous body of geological literature. Ridge push, slab pull and continental drag (GDR) have been evaluated by a number of investigators. Ridge push, slab pull and continental drag are found to be sizable forces. Trench suction may be a real force, but because effective trench lengths are relatively small and only three of the twelve plates considered are subducting, it is not a first-order significant contributor to plate motions.
The geological relation
$$\dot{\varepsilon}_{max}/\dot{\varepsilon}_{min} = (\sigma_1 - \sigma_3)/(\sigma_2 - \sigma_3)$$
is a remarkably good predictor of average plate velocities, with an rms error of 0.70 cm/yr, and a correlation coefficient of 0.96. The relationship between these two factors is essentially consistent with the results of finite element models. The constant term in this relation is not statistically considered, and suggests that the assumed effects of such forces are about equal for all plates. Finally, because the relative forces for any particular plate are independent of all other plates, the success of this relationship strongly suggests that the forces which drive plate motions are intimately related to the plate interfaces.
(Geophys. Res. Lett., Paper 11L023

6130 Plate tectonics
THE JOAN DE FUCA RIDGE--THE FIRST-PROPAGATING RIFT SYSTEM: NEW TECTONIC, GEOCHEMICAL, AND MAGNETIC DATA
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Following DSP Leg 69 marine work, and preliminary geochemical and magnetic studies, from a 1979 cruise to the Juan de Fuca Ridge, allow the following interpretations: 1. The central rift zone (between 45.5°N and 49.5°N) of the Juan de Fuca Ridge is now actively spreading from a zone with an 80 to 90 km width of the axis bisected by the Brunhes-Matuyama magnetic reversal boundary. 2. The present-day portions of sufficient lengths are actively propagating to the north and to the south. Cobb-Trangsmore' has been identified by dredging and remote work; the tip appears formed, or offset slightly, to the west, does not correspond to the northernmost tip of the central magnetic anomaly (Blanco on adv. 1974), and spreading has been initiated beneath sediments farther north. 3. Iron and titanium in fresh glasses from the active volcanic zone exhibit a progressive enrichment eastward, then a pronounced recession to more 'normal' concentrations in the vicinity of the Cobb Offset.
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